NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

RESEARCH MEMORANDUM

SOME TESTS OF THE LONGITUDINAL STABILITY AND CONTROL OF AN H-13B HELICOPTER IN FORWARD FLIGHT

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SUMMARY

An H-13B helicopter was flown by NACA personnel for the purpose of obtaining some data on the longitudinal stability and control characteristics in forward flight. This paper presents samples of recorded time histories together with the pilot's comments. Stick-fixed longitudinal stability exhibited in pull-ups was considered satisfactory. Longitudinal oscillations with stick fixed were heavily damped and the helicopter could be flown hands-off for relatively long periods in mildly rough air. In general, the control stick (cyclic pitch control) had no force gradients to provide "feel" in maneuvering flight. The control forces were never high.

INTRODUCTION

An H-13B helicopter (Army No. 48-798), belonging to the Office of the Chief, Army Field Forces, was flown by NACA personnel for the purpose of measuring some of the longitudinal stability and control characteristics of this helicopter. In particular, since the pilot had (following a previous familiarization flight) stated that the stick-fixed longitudinal characteristics were satisfactory, it was desired to obtain time histories of longitudinal maneuvers for correlation with this observation. The test conditions for the instrumented flight were kept as close as possible to those of the previous flight, and no information has been obtained concerning possible effects of aircraft center of gravity, removal of bubble canopy, or similar permissible changes.

TESTS AND RESULTS

The test h-licopter was flown with bubble canopy and doors installed and with a total of 374 pounds (pilot, instruments, and ballast) weight in the cockpit. Normal operating procedure for this helicopter calls for the installation of a small horizontal tail surface in case the bubble canopy is removed. Since the bubble canopy was installed, no horizontal tail surface was required. Fuel at takeoff was approximately 32 gallons and at landing approximately 16 gallons. No baggage was carried other than the blade mooring-block assembly. Figure 1 is a photograph of the test helicopter.

Data recorded in flight were longitudinal stick position, pitching angular velocity, and normal acceleration. Instrumentation consisted of standard NACA individual film-recording instruments assembled together with a master timer, battery, switches, and wiring into a self-contained portable seat installation which was clamped to the right-hand seat in the side-by-side cabin. The control-position-recorder string was tied directly to the right-hand control stick to measure longitudinal stick motion. A photograph of the instrument assembly is given in figure 2.

Test maneuvers consisted of pull-ups in which the cyclic control stick was deflected aft abruptly from the trim position and held until the maximum normal acceleration was reached and of attempted longitudinal oscillations in which the stick was deflected from trim to initiate a disturbance and then returned to trim and held fixed. The maneuvers were performed from level flight at a pressure altitude of 500 feet at indicated airspeeds of 60, 70, and 80 miles per hour. Sample data are presented in figures 3 to 5. The record lines in these figures were faired to eliminate high-frequency irregularities due to helicopter vibration.

The pull-up time histories (figs. 3 and 4) show that it was not necessary for the pilot to effect recovery until after the maximum normal acceleration had been reached. The oscillation time history (fig. 5) shows that in this case the motion of the aircraft following a disturbance was essentially deadbeat.

PILOT'S COMMENTS

The pilot's comments are as follows:

(a) The stick-fixed longitudinal stability exhibited in pull-ups was satisfactory. The manner of development of normal acceleration following stick motion caused the pilot no apprehension.

(b) Longitudinal oscillations with control fixed were heavily damped.

(c) The helicopter could be flown with stick fixed for relatively long periods in mildly rough air.

(d) It was not possible to trim steady stick-control forces to zero. A bothersome out-of-trim lateral force was present in all flight conditions and on the ground. Longitudinal out-of-trim forces existed but were always small.

(e) With the adjustable friction device on the right stick loosened, the friction in the cyclic controls was moderate. Some further reduction in friction would probably be advantageous.

(f) In general, the control stick (cyclic pitch control) had no force gradients to provide "feel" in maneuvering flight. The control forces were never high. The introduction of artificial force gradients by the use of light springs or as the byproducts of adjustable bungees would appear to be desirable.

(g) The collective-pitch lever did not have sufficient friction to prevent it from continually creeping toward low pitch in flight. The modification of the collective-pitch mechanism to eliminate collective-pitch creep in cruising flight conditions would appear to be desirable.

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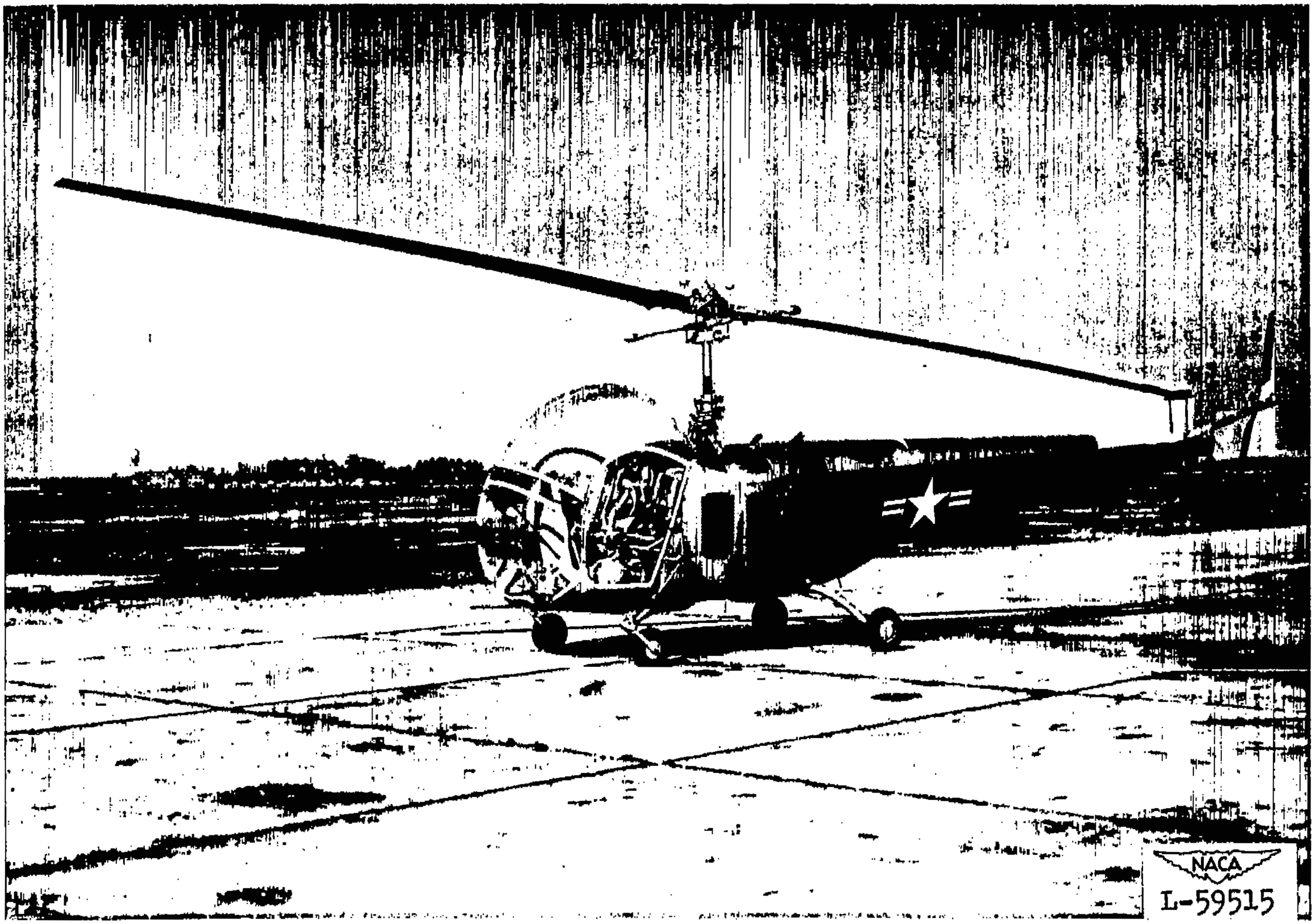

Figure 1.- Photograph of H-13B helicopter.

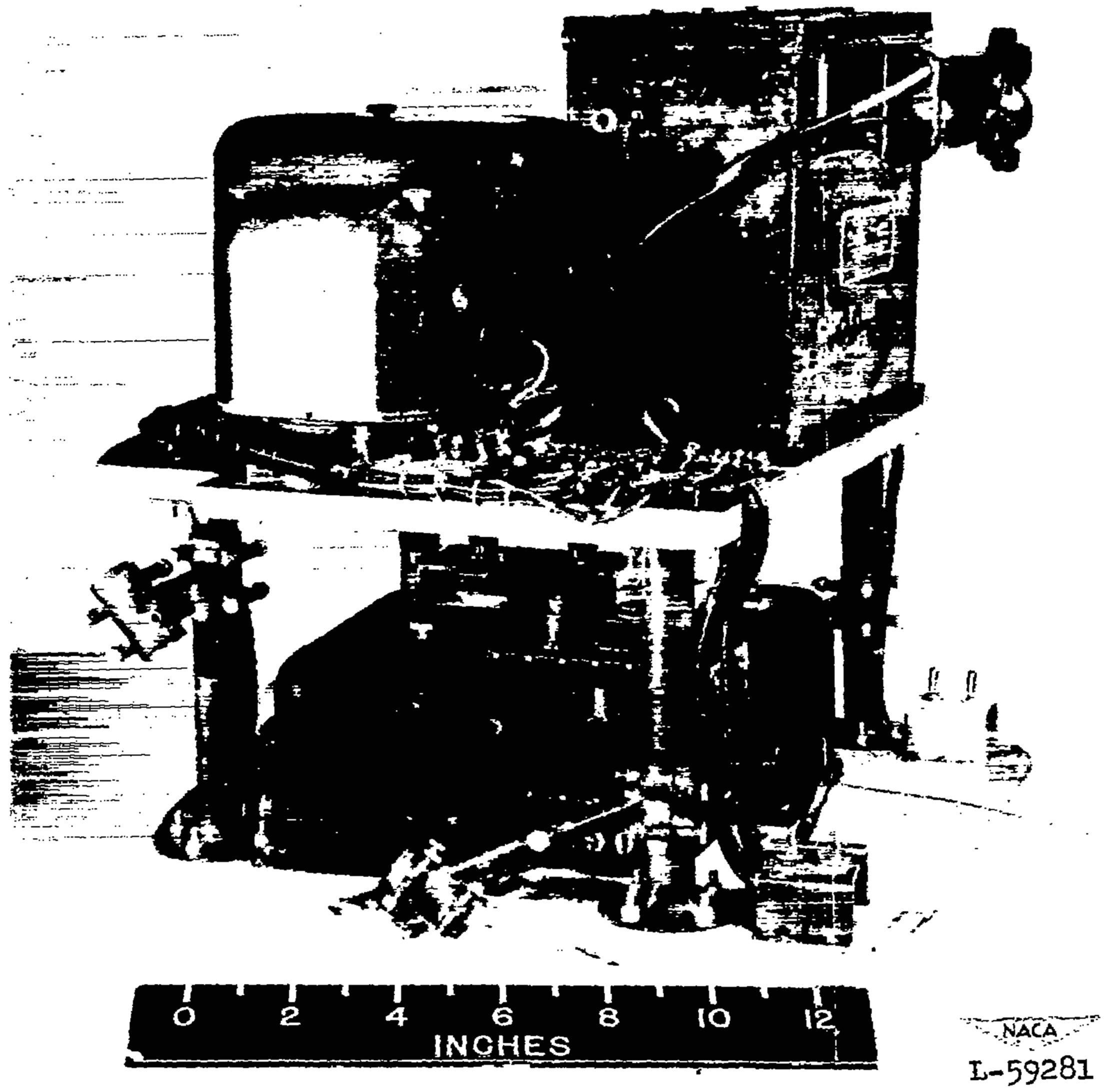

Figure 2.- Photograph of NACA portable instrument assembly.

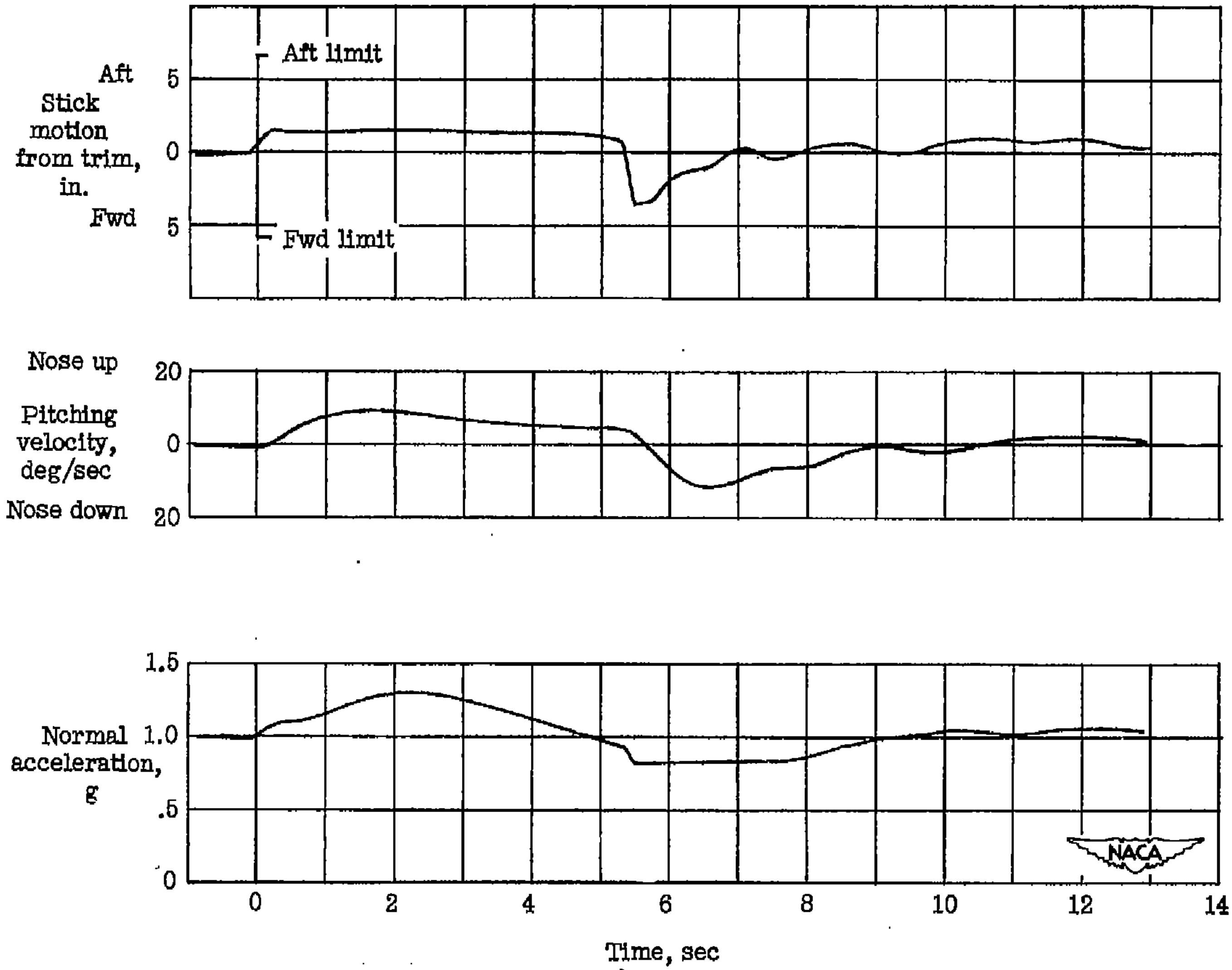

Figure 3.- Pull-up at 60 miles per hour.

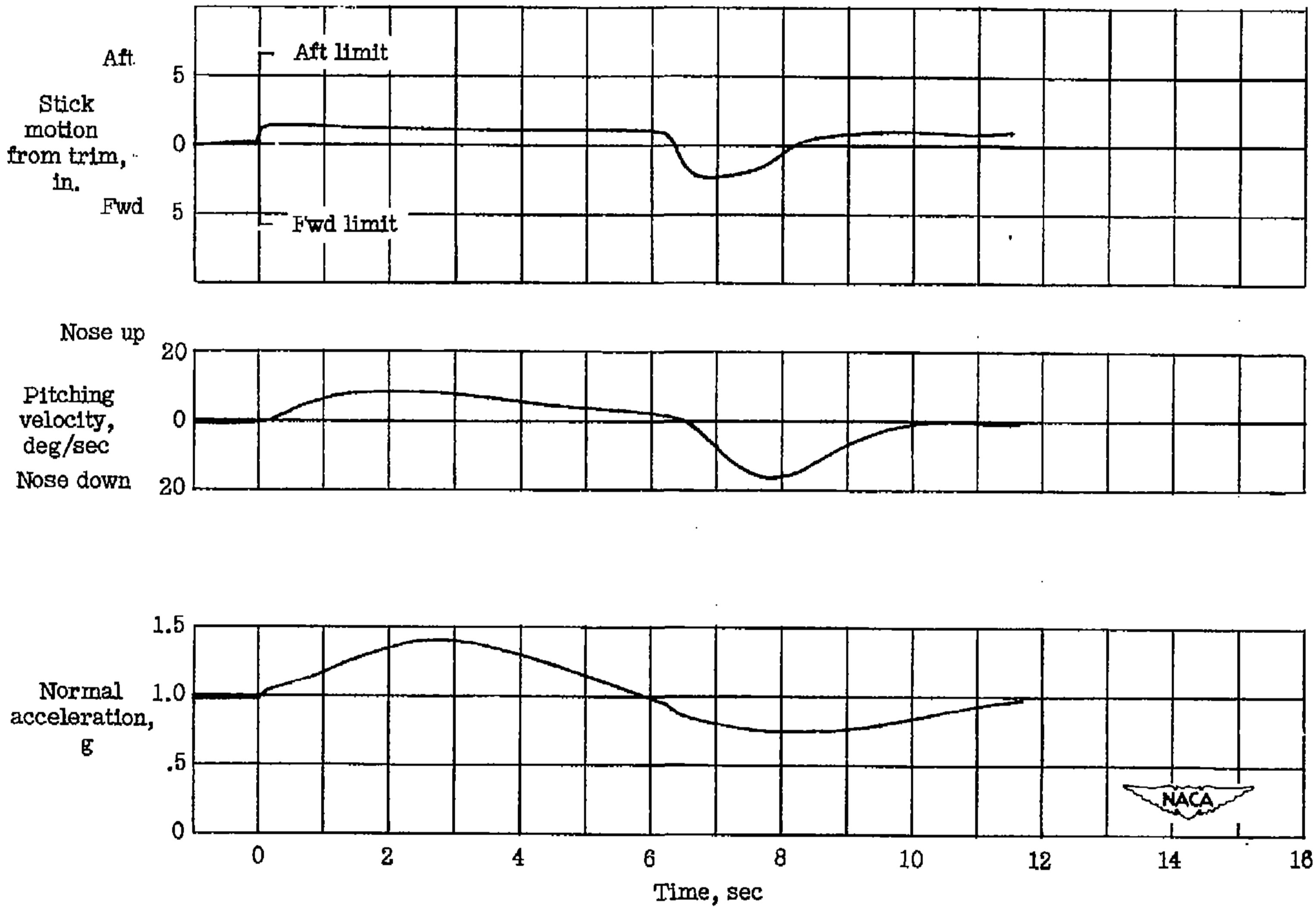

Figure 4.- Pull-up at 80 miles per hour.

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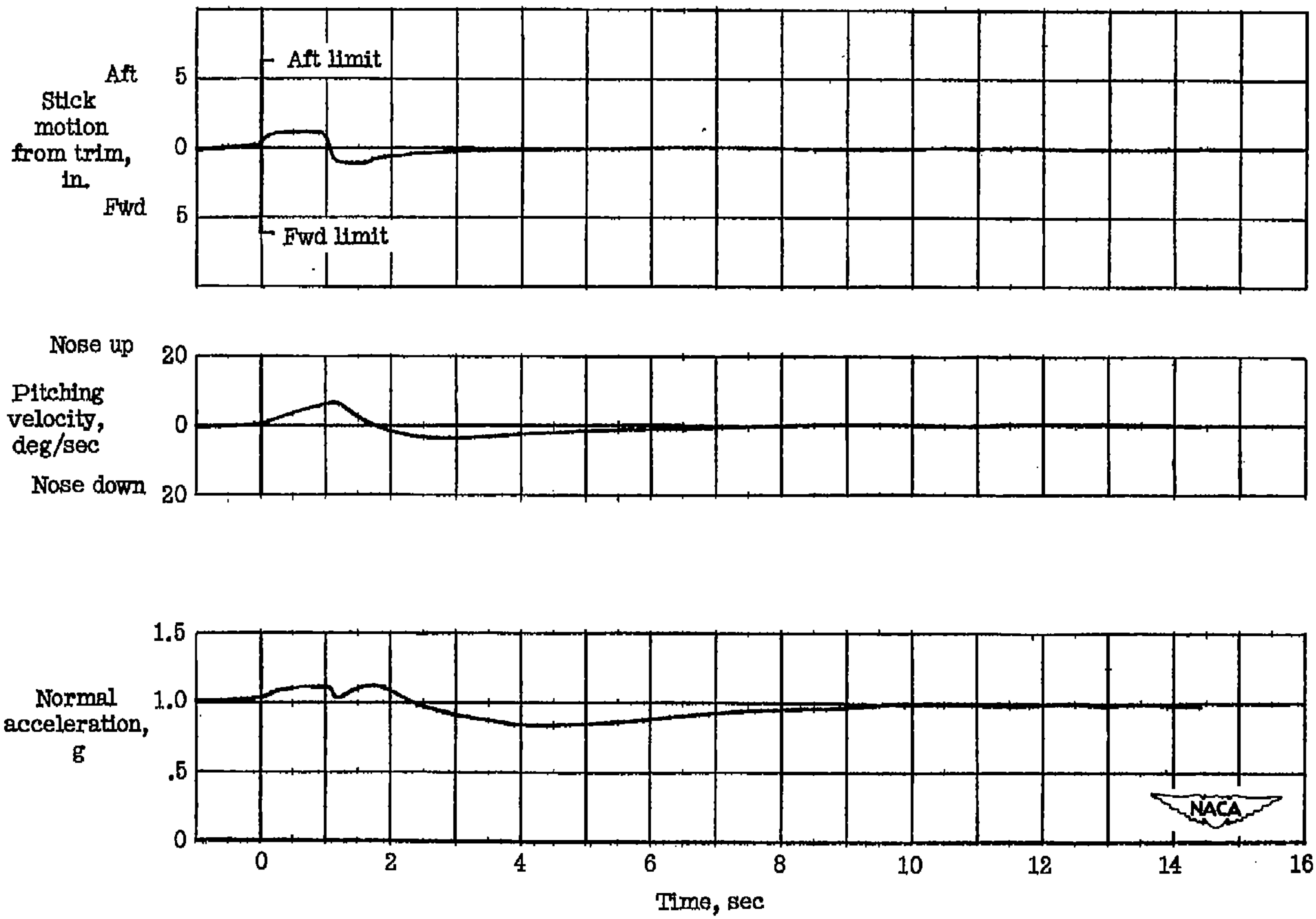

Figure 5.- Oscillation at 80 miles per hour.